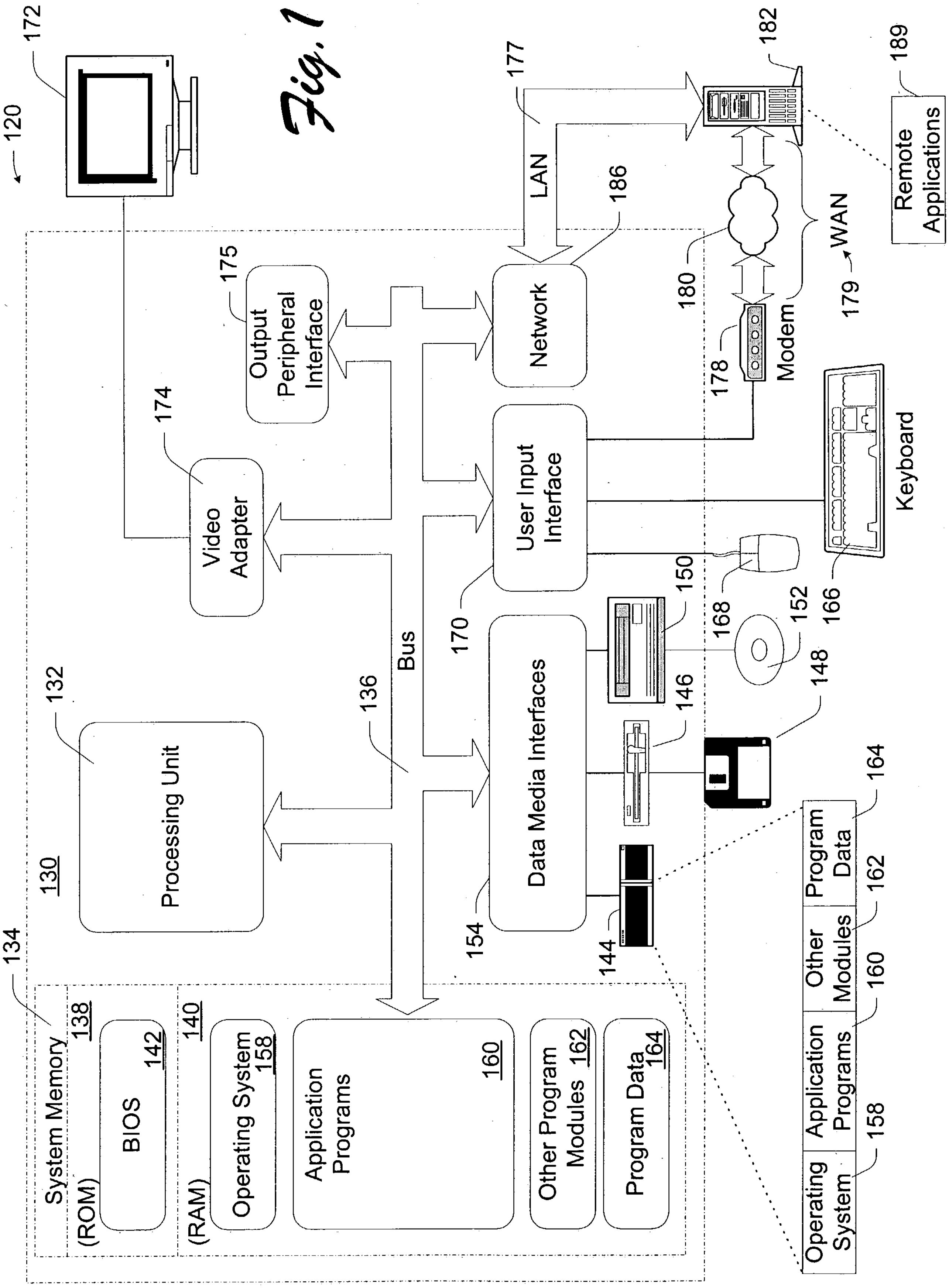

120
172
174
175
177
182
189
Remote Applications
LAN
186
Output Peripheral Interface
Network
180
WAN
179
Modem
178
Keyboard
User Input Interface
Video Adapter
170
Bus
168
150
152
166
Processing Unit
132
136
Data Media Interfaces
146
148
130
154
144
164
Program Data
162
Other Modules
160
Application Programs
158
Operating System
134
System Memory
(ROM)
138
BIOS
142
(RAM)
140
Operating System
158
Application Programs
160
Other Program Modules
162
Program Data
164

Fig. 1

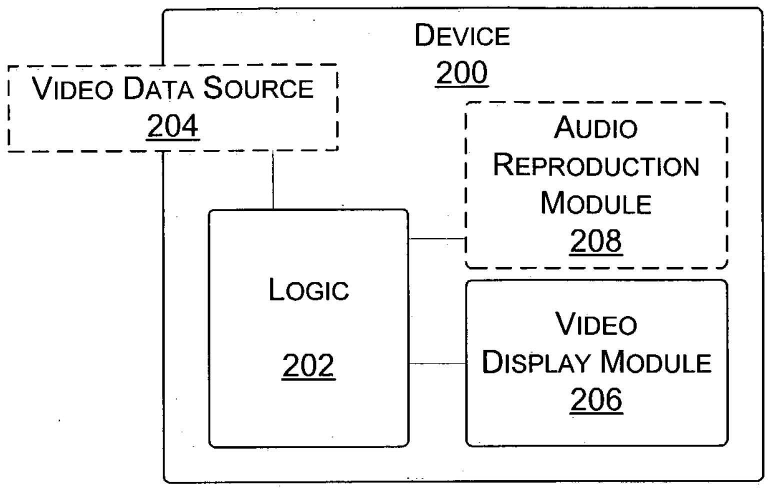

DEVICE
200
VIDEO DATA SOURCE
204
AUDIO
REPRODUCTION
MODULE
208
LOGIC
202
VIDEO
DISPLAY MODULE
206

*Fig. 2*

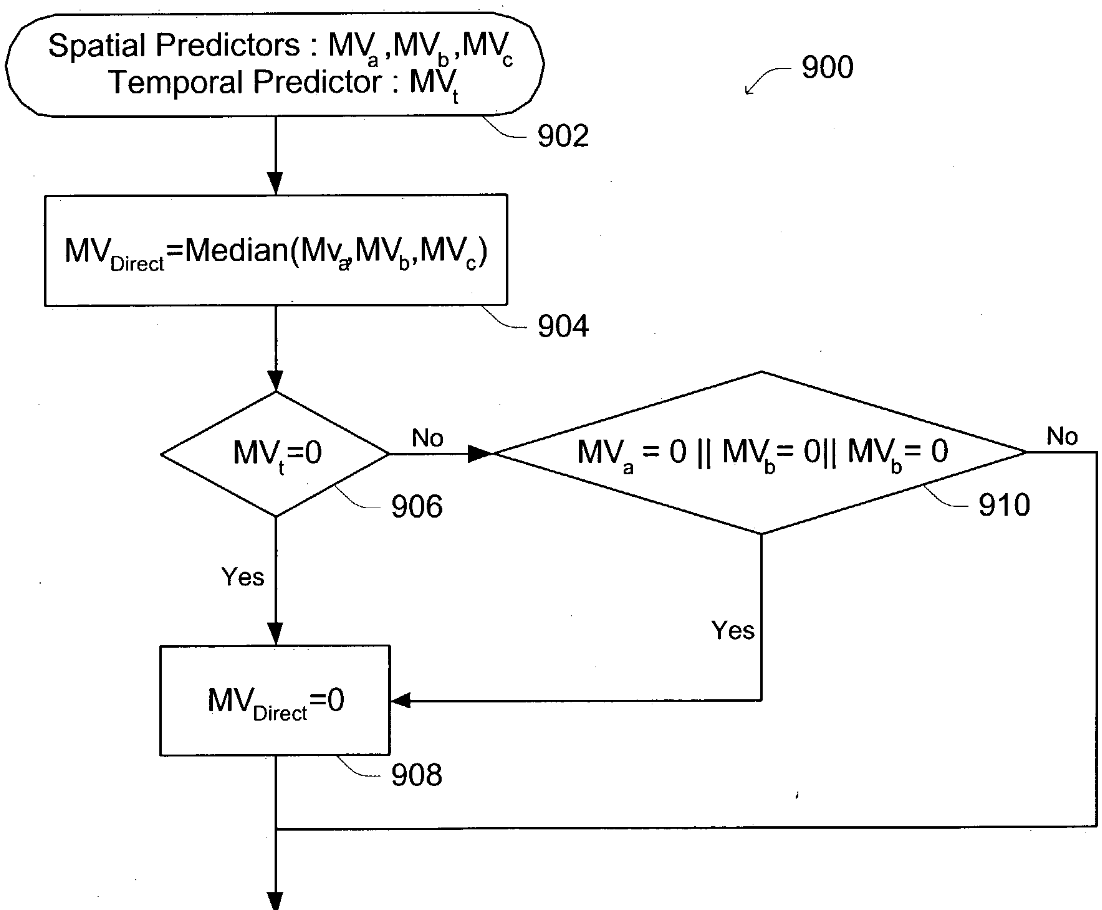

Spatial Predictors : MVa ,MVb ,MVc
Temporal Predictor : MVt
900
902
MVDirect=Median(Mva,MVb,MVc)
904
MVt=0
No
906
MVa = 0 || MVb= 0|| MVb= 0
No
910
Yes
Yes
MVDirect=0
908

*Fig. 9*

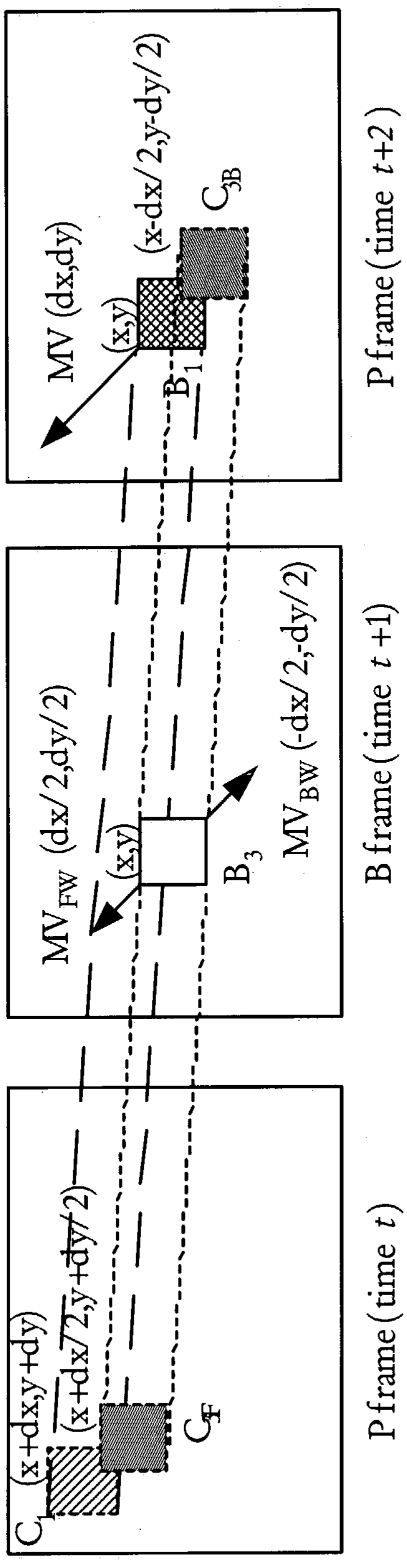

MV (dx,dy)
(x,y)
(x-dx/2,y-dy/2)
$C_{3B}$
$B_1$
P frame (time $t$+2)
$MV_{FW}$ (dx/2,dy/2)
(x,y)
$B_3$
$MV_{BW}$ (-dx/2,-dy/2)
B frame (time $t$+1)
$C_1$
(x+dx,y+dy)
(x+dx/2,y+dy/2)
$C_F$
P frame (time $t$)

*Fig. 3*

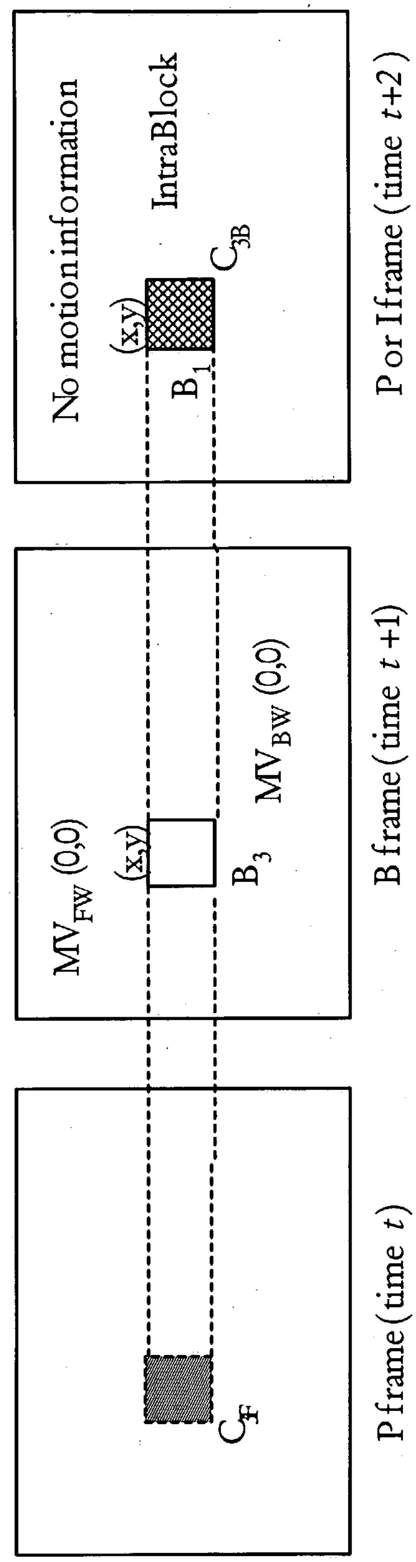

No motion information
IntraBlock
(x,y)
$C_{3B}$
$B_1$
P or I frame (time $t$+2)
$MV_{FW}$ (0,0)
(x,y)
$B_3$
$MV_{BW}$ (0,0)
B frame (time $t$+1)
$C_F$
P frame (time $t$)

*Fig. 4*

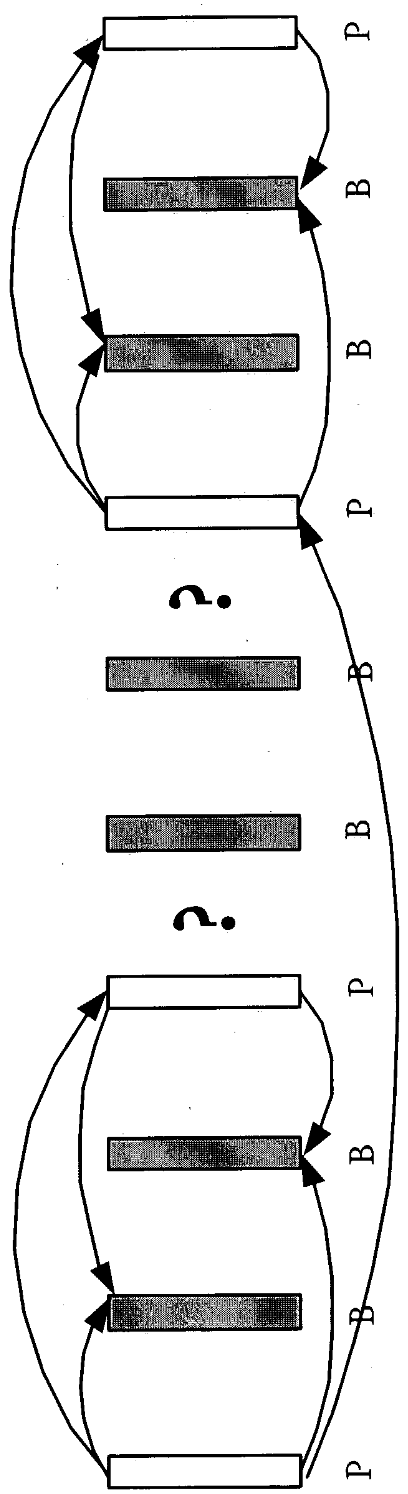



Fig. 5

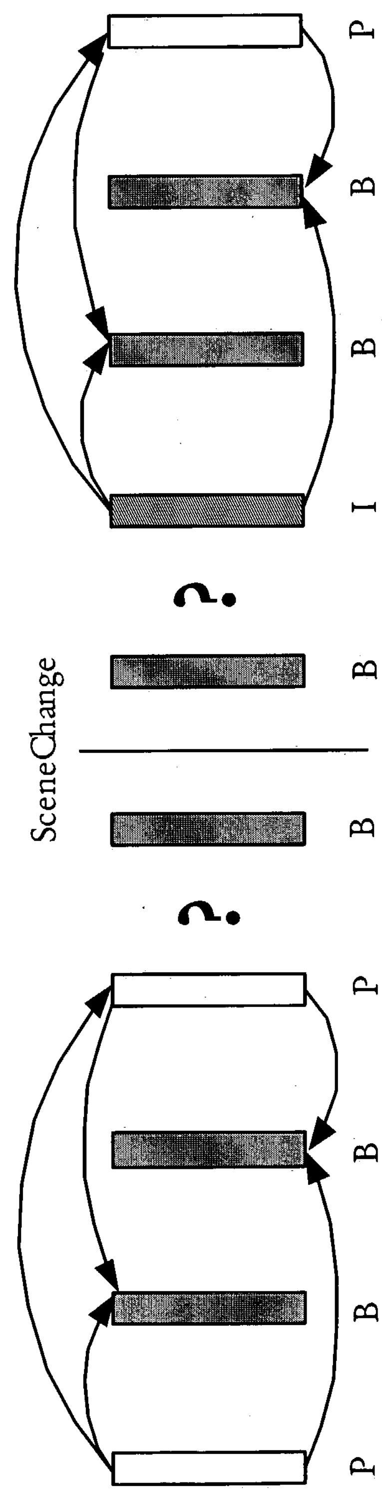



Fig. 6

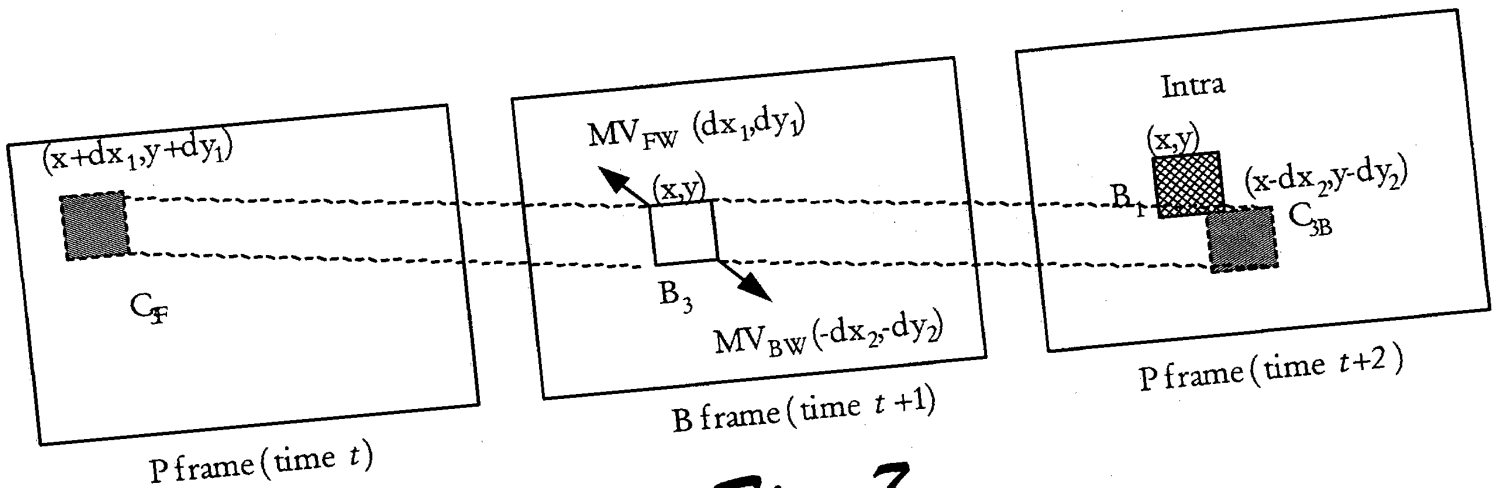

(x+dx1,y+dy1)
CF
P frame (time t)
MVFW (dx1,dy1)
(x,y)
B3
MVBW (-dx2,-dy2)
B frame (time t +1)
Intra
(x,y)
B1
(x-dx2,y-dy2)
C3B
P frame (time t+2)

Fig. 7

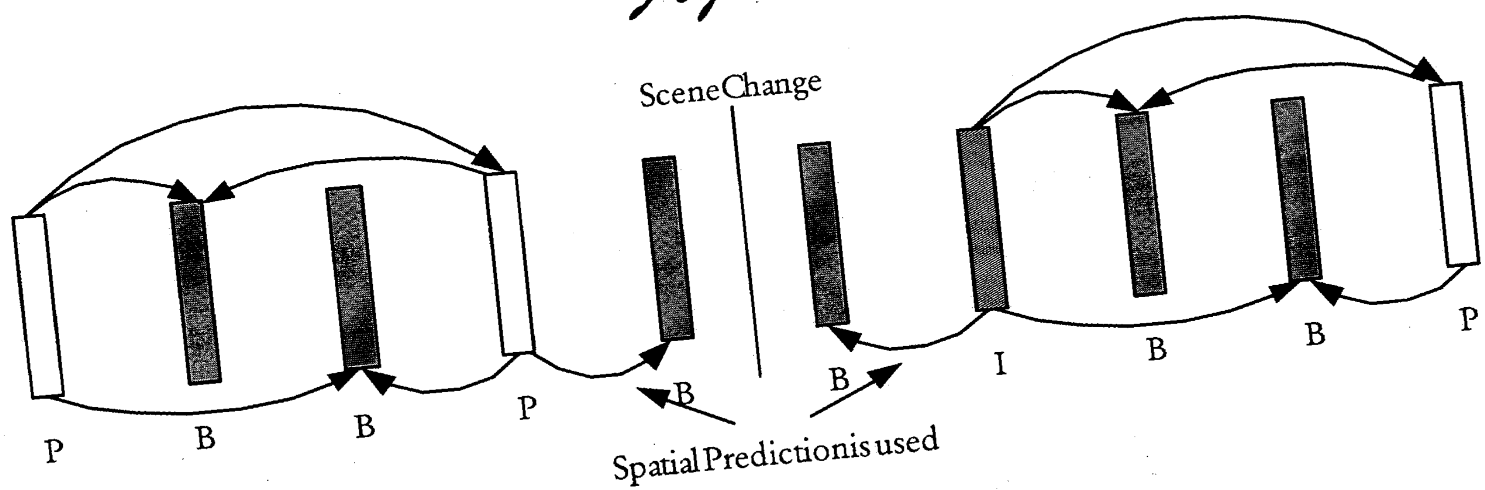

Scene Change
P
B
B
P
B
B
I
B
B
P
Spatial Prediction is used

Fig. 8

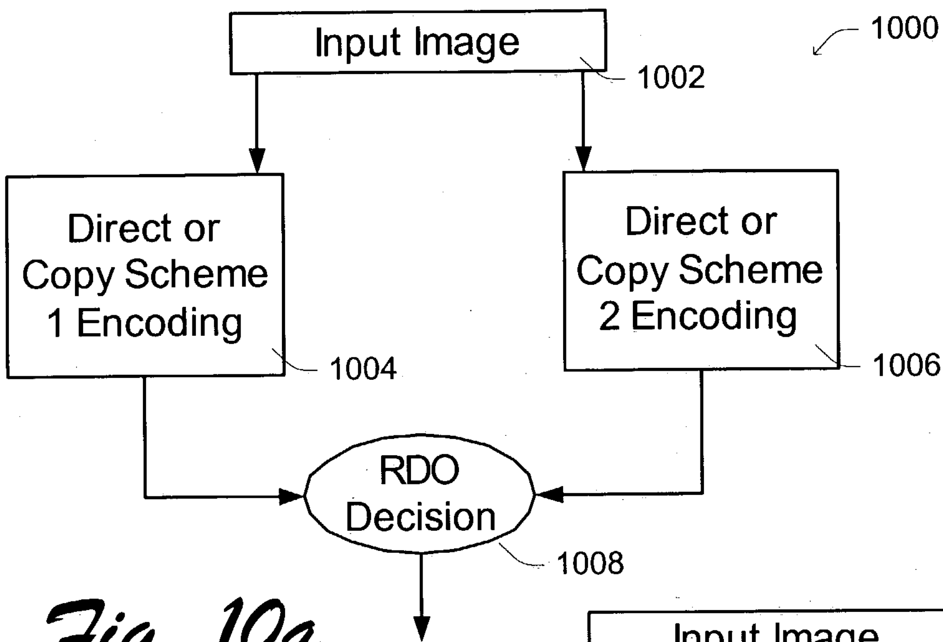



Fig. 10a

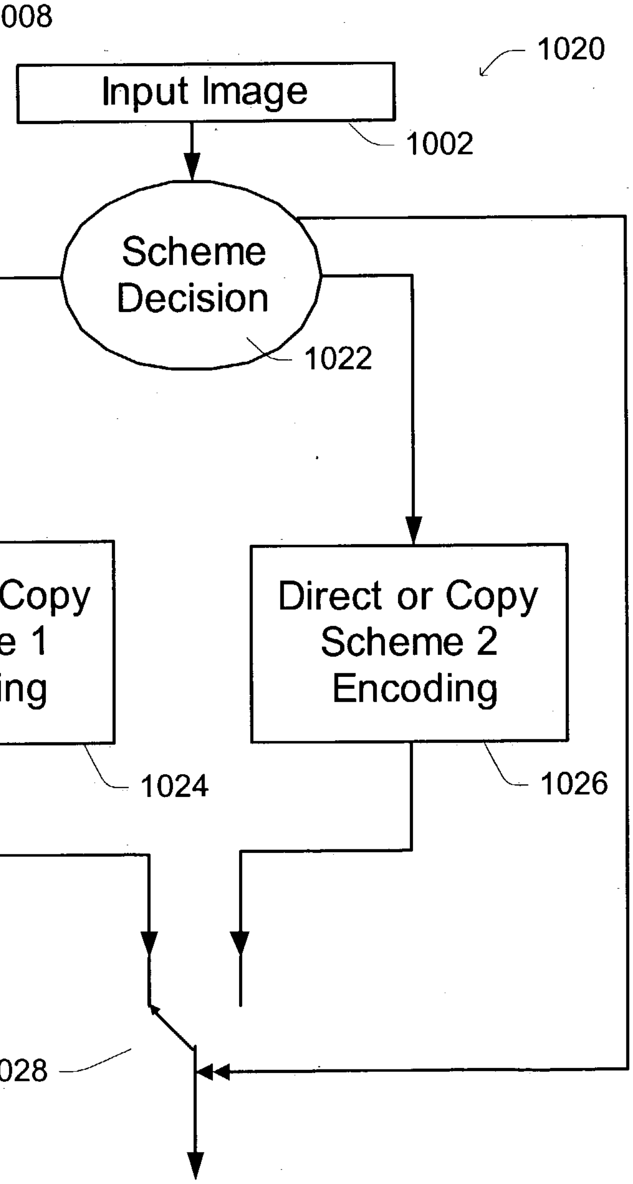



Fig. 10b

| slice_header( ) { | Category | Descriptor |
|---|---|---|
| **parameter_set_id** | 4 | e( v ) |
| **first_mb_in_slice** | 4 | e( v ) |
| if ( coding_type( ) = = Inter \|\| coding_type( ) = = Bipred ) { | | |
| **num_ref_pic_active_fwd_minus1** | 4 | e( v ) |
| if( coding_type( ) = = Bipred ) | | |
| **num_ref_pic_active_bwd_minus1** | 4 | e( v ) |
| if( coding_type( ) = = Inter ) | | |
| **copy_mv_spatial** | 4 | u(1) or e(v) |
| if( coding_type( ) = = Bipred ) { | | |
| **direct_mv_spatial** | 4 | u(1) or e(v) |
| if( direct_mv_spatial) { | | |
| **direct_mv_scale_fwd** | **4** | **e( v )** |
| **direct_mv_scale_bwd** | **4** | **e( v )** |
| **direct_mv_scale_divisor** | **4** | **e( v )** |
| } | | |
| **explicit_B_prediction_block_weight_indication** | | **e( v )** |
| if ( explicit_B_prediction_block_weight_indication > 1 ) | | |
| adaptive_B_prediction_coeff_table( ) | | |
| } | | |
| } | | |
| rps_layer( ) | | |
| **slice_qp_minus26** /* relative to 26 */ | 4 | e( v ) |
| if( coding_type( ) = = SP \|\| coding_type( ) = = SI ) { | | |
| if (coding_type( ) == SP) | | |
| **sp_for_switch_flag** | 4 | u( 1 ) |
| **slice_qp_s_minus26** /* relative to 26 */ | 4 | e( v ) |
| } | | |
| if( entropy_coding_mode = = 1 ) | | |
| **num_mbs_in_slice** | 4 | e( v ) |
| } | | |

*Fig. 11*

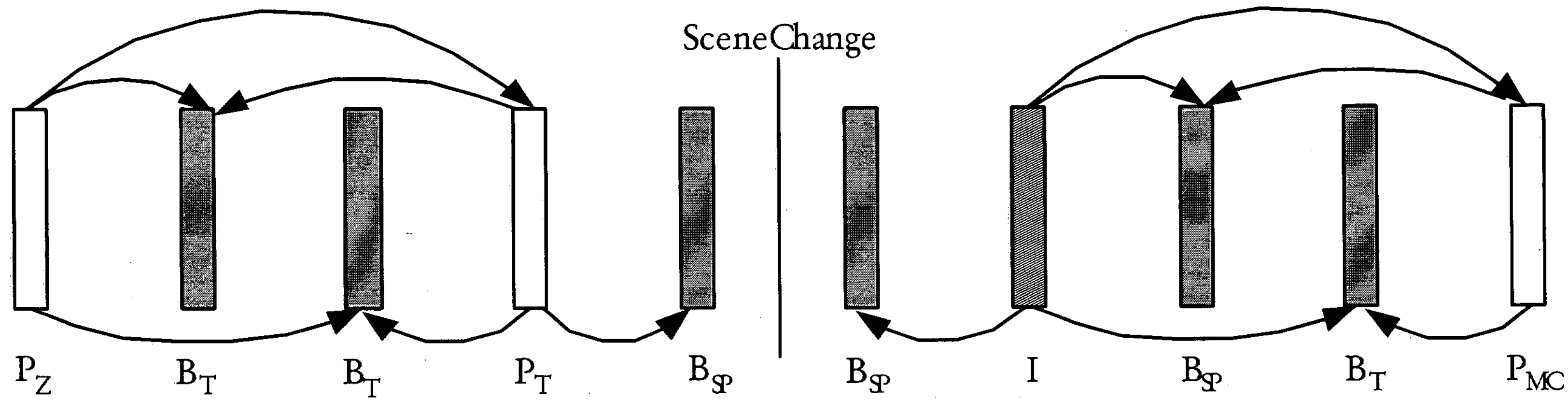

SceneChange
$P_Z$
$B_T$
$B_T$
$P_T$
$B_{SP}$
$B_{SP}$
I
$B_{SP}$
$B_T$
$P_{MC}$

Fig. 12

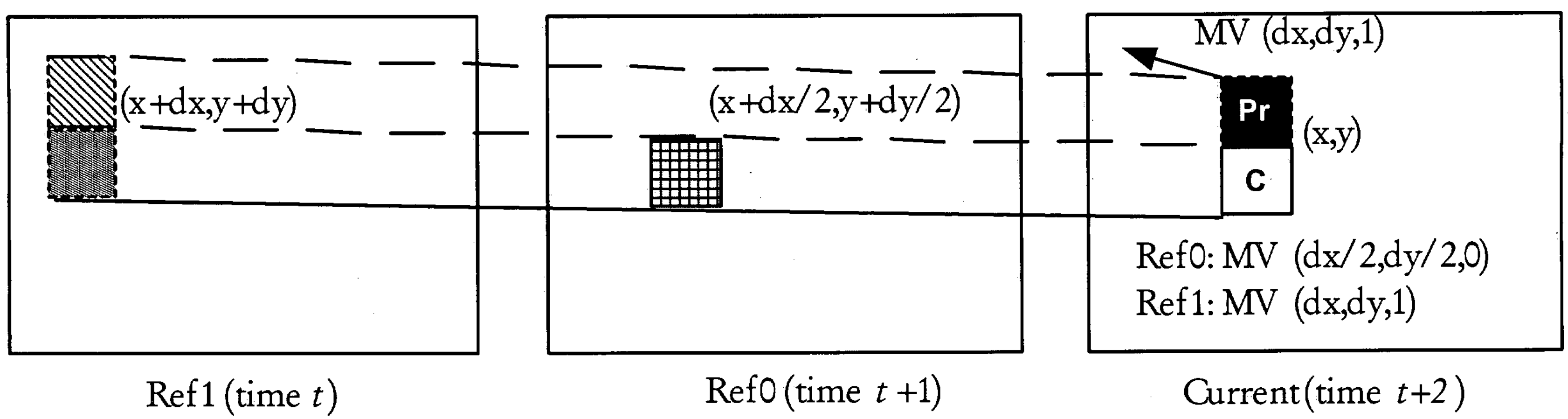

(x+dx,y+dy)
(x+dx/2,y+dy/2)
MV (dx,dy,1)
Pr
(x,y)
C
Ref0: MV (dx/2,dy/2,0)
Ref1: MV (dx,dy,1)
Ref1 (time t)
Ref0 (time t +1)
Current (time t+2 )

Fig. 18

Modes for 8x8 blocks in B pictures/slices

| Code number | 8x8 partition mode | num_subblock_block8x8( ) | block_prediction_mode( ) |
|---|---|---|---|
| 0 | Direct8x8 | 1 | Direct |
| 1 | 8x8 | 1 | Fwd |
| 2 | 8x8 | 1 | Bwd |
| 3 | 8x8 | 1 | Bipred |
| 4 | 8x4 | 2 | Fwd |
| 5 | 4x8 | 2 | Fwd |
| 6 | 8x4 | 2 | Bwd |
| 7 | 4x8 | 2 | Bwd |
| Removed | 8x4 | 2 | Bipred |
| Removed | 4x8 | 2 | Bipred |
| 8 | 4x4 | 4 | Fwd |
| 9 | 4x4 | 4 | Bwd |
| Removed | 4x4 | 4 | Bipred |
| 10 | Intra8x8 | 1 | Intra |

Fig. 13

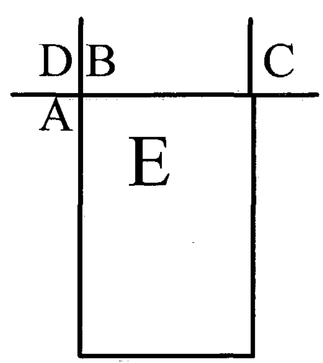
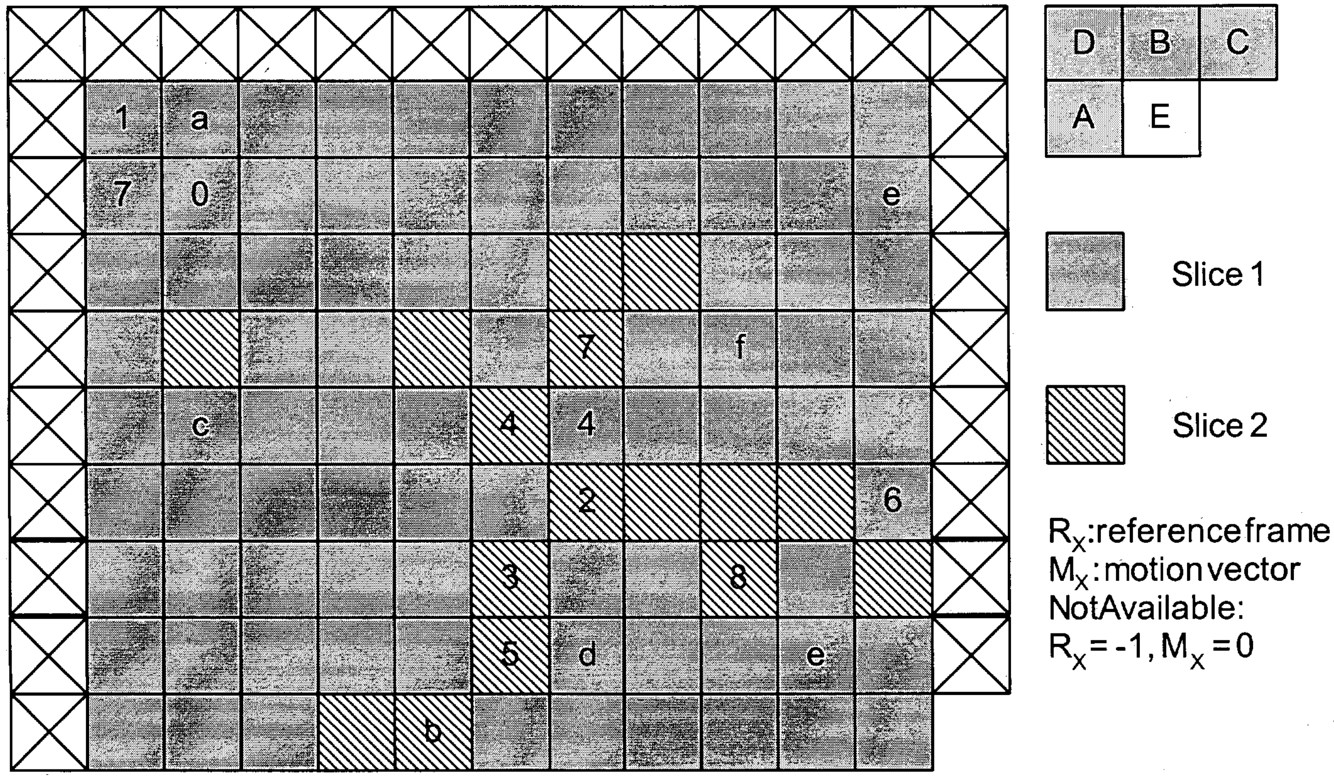



Fig. 14

P-Picture Motion Vector Prediction (Non-Skip, non-8x16, non-16x8 MBs)

| Availability of Neighbor MV | | | | MV Prediction $v_E$ derivation for E | Defined |
|---|---|---|---|---|---|
| A | B | C | D | | |
| 0 | 0 | 0 | 0 | **1st rule:** $v_A=0$; $v_D=0$; $r_A \neq r_E$; $r_D \neq r_E$;<br>**2nd rule:** $v_E=v_A=0$; | √ |
| 0 | 0 | 0 | 1 | **3rd rule:** $v_C=v_D$; $r_C=r_D$;<br>$v_E$ Not defined since $v_A$ not defined. | × |
| 0 | 0 | 1 | 0 | **1st rule:** $v_A=0$; $v_D=0$; $r_A \neq r_E$; $r_D \neq r_E$;<br>$v_E$ Not defined since $v_B$ not defined. | × |
| 0 | 0 | 1 | 1 | $v_E$ Not defined since $v_A$ and $v_B$ not defined. | × |
| 0 | 1 | 0 | 0 | **1st rule:** $v_A=0$; $v_D=0$; $r_A \neq r_E$; $r_D \neq r_E$;<br>**3rd rule:** $v_C=v_D=0$; $r_C=r_D \neq r_E$;<br>**4th rule: if B uses same reference picture as E, then** $v_E=v_B$; **else** $v_E$=median($v_A$, $v_B$, $v_C$)=median($0$, $v_B$, $0$)=$0$; | √ |
| 0 | 1 | 0 | 1 | **3rd rule:** $v_C=v_D$; $r_C=r_D$<br>$v_E$ Not defined since $v_A$ not defined. | √ |
| 0 | 1 | 1 | 0 | **1st rule:** $v_A=0$; $v_D=0$; $r_A \neq r_E$; $r_D \neq r_E$;<br>**4th rule: if one and only one of B, C uses same reference picture as E, then**<br>$v_E=v_B$ or $v_C$ (whichever uses same ref pic); **else** $v_E$=median($v_A$, $v_B$, $v_C$)=median($0$, $v_B$, $v_C$); [even if $v_B$ and $v_C$ use different reference pictures than $v_E$] | √ |
| 0 | 1 | 1 | 1 | $v_E$ Not defined since $v_A$ not defined. | × |
| 1 | 0 | 0 | 0 | **2nd rule:** $v_E=v_A$; | √ |
| 1 | 0 | 0 | 1 | **3rd rule:** $v_C=v_D$; $r_C=r_D$<br>$v_E$ Not defined since $v_B$ not defined. | × |
| 1 | 0 | 1 | 0 | $v_E$ Not defined since $v_B$ not defined. | × |
| 1 | 0 | 1 | 1 | $v_E$ Not defined since $v_B$ not defined. | × |
| 1 | 1 | 0 | 0 | **3rd rule:** $v_C=v_D$; $r_C=r_D$<br>$v_E$ Not defined since $v_D$ not defined. | × |
| 1 | 1 | 0 | 1 | **3rd rule:** $v_C=v_D$; $r_C=r_D$<br>**4th rule: if one and only one of A, B, C(D) uses same reference picture as E, then**<br>$v_E=v_A$ or $v_B$ or $v_C$ (whichever uses same ref pic); **else** $v_E$=median($v_A$, $v_B$, $v_C$); [even if one or two of $v_A$, $v_B$ and $v_C$ use different reference pictures than $v_E$] | √ |
| 1 | 1 | 1 | 0 | **4th rule: if one and only one of A, B, C uses same reference picture as E, then**<br>$v_E=v_A$ or $v_B$ or $v_C$ (whichever uses same ref pic); **else** $v_E$=median($v_A$, $v_B$, $v_C$) [even if one or two of $v_A$, $v_B$ and $v_C$ use different reference pictures than $v_E$] | √ |
| 1 | 1 | 1 | 1 | **4th rule: if one and only one of A, B, C uses same reference picture as E then**<br>$v_E=v_A$ or $v_B$ or $v_C$ (whichever uses same ref pic); **else** $v_E$=median($v_A$, $v_B$, $v_C$); [even if one or two of $v_A$, $v_B$ and $v_C$ use different reference pictures than $v_E$] | √ |

*Fig. 15*

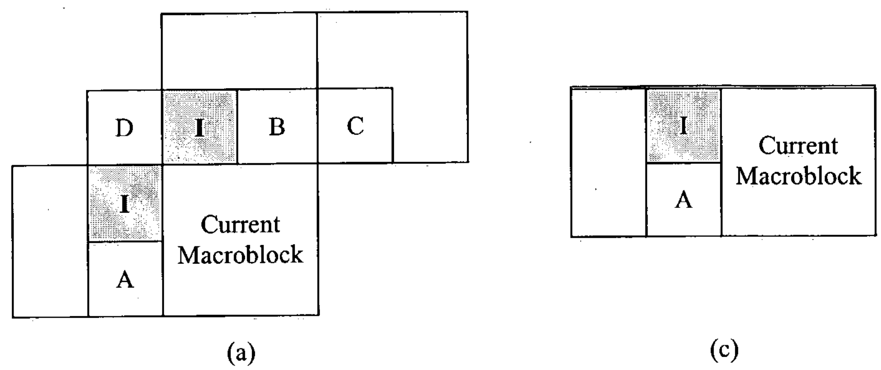



| Not Available Blocks | | | | |
|---|---|---|---|---|
| **A** | **B** | **C** | **D** | **case** |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 2 |
| 0 | 0 | 1 | 0 | 3 |
| 0 | 0 | 1 | 1 | 4 |
| 0 | 1 | 0 | 0 | 5 |
| 0 | 1 | 0 | 1 | 6 |
| 0 | 1 | 1 | 0 | 7 |
| 0 | 1 | 1 | 1 | 8 |
| 1 | 0 | 0 | 0 | 9 |
| 1 | 0 | 0 | 1 | a |
| 1 | 0 | 1 | 0 | b |
| 1 | 0 | 1 | 1 | c |
| 1 | 1 | 0 | 0 | d |
| 1 | 1 | 0 | 1 | e |
| 1 | 1 | 1 | 0 | f |
| 1 | 1 | 1 | 1 | 0 |

<u>JVTRules:</u>

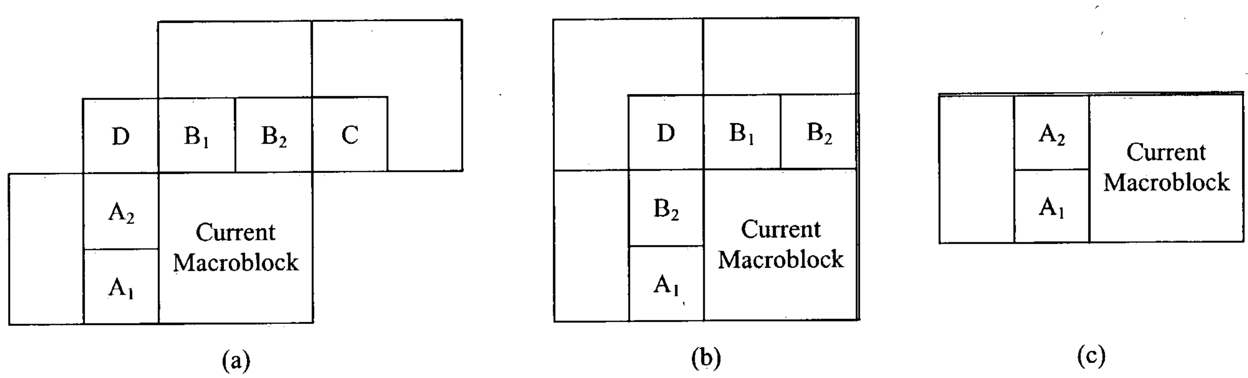
R0: Median rule is applied for Motion vector calculation: $M_E$=Median($M_A$,$M_B$,$M_C$)
R1: A, D outside of picture => $R_A = R_D = -1$, $M_A = M_D = 0$
R2: B, C, D outside of picture => $M_E = M_A$
R3: C not available (outside of picture, not yet coded etc) C is replaced by D
R4: if X is intra, then $R_X$ =-1 (no definition on $M_X$ - code sets $R_X = -1$, $M_X = 0$)
R5: if X ($X \in \{A, B, C\}$) and only X has $R_X == R_E$ then $M_E = M_X$

*Fig. 16*



D
I
B
C
I
Current
Macroblock
A
(a)
I
Current
Macroblock
A
(c)


*Fig. 17*



D
$B_1$
$B_2$
C
$A_2$
Current
Macroblock
$A_1$
(a)
D
$B_1$
$B_2$
$B_2$
Current
Macroblock
$A_1$
(b)
$A_2$
Current
Macroblock
$A_1$
(c)


*Fig. 19*

Relationship between previous $\lambda$ and current one.

| $QP$ | $\lambda_{I,P}^{\Pr ev} = 5 \times \frac{QP+5}{34-QP} \times \exp^{\frac{QP}{10}}$ | $\lambda_{I,P}^{Curr} = 0.85 \times 2^{\frac{QP}{3}}$ | $\frac{\lambda_{I,P}^{Curr} - \lambda_{I,P}^{\Pr ev}}{\lambda_{I,P}^{Curr}}$ |
|---|---|---|---|
| 16 | 28.89 | 34.27 | 18.61% |
| 17 | 35.42 | 43.18 | 21.90% |
| 18 | 43.48 | 54.40 | 25.11% |
| 19 | 53.49 | 68.54 | 28.14% |
| 20 | 65.97 | 86.35 | 30.89% |
| 21 | 81.66 | 108.80 | 33.23% |
| 22 | 101.53 | 137.08 | 35.01% |
| 23 | 126.94 | 172.71 | 36.05% |
| 24 | 159.84 | 217.60 | 36.14% |
| 25 | 203.04 | 274.16 | 35.03% |
| 26 | 260.86 | 345.42 | 32.42% |
| 27 | 340.11 | 435.20 | 27.96% |
| 28 | 452.23 | 548.32 | 21.25% |

Fig. 20

Performance different of Proposed Schemes/Draft text and proposed RDO vs current software (JM3.3)

| ***Scheme*** | **ref** | **Entropy** | **Sequence** | **Foreman** | **Container** | **News** | **Paris** | **Silence** | **Mobile** | **Tempete** |
|---|---|---|---|---|---|---|---|---|---|---|
| MVP | 1 | UVLC | PSNR gain | 0.190 | 0.076 | -0.027 | 0.270 | 0.099 | 0.220 | -0.135 |
| | | | Bitrate diff | 3.43% | 1.39% | -0.47% | 5.04% | 2.06% | 4.43% | -3.53% |
| | 5 | UVLC | PSNR gain | 0.221 | 0.037 | 0.004 | 0.318 | 0.129 | 0.256 | -0.156 |
| | | | Bitrate diff | 3.98% | 0.59% | 0.07% | 5.96% | 2.66% | 4.81% | -4.00% |
| MVP | 1 | CABAC | PSNR gain | 0.081 | 0.022 | -0.026 | 0.194 | 0.062 | 0.116 | -0.167 |
| | | | Bitrate diff | 1.52% | 0.40% | -0.45% | 3.65% | 1.25% | 2.32% | -4.32% |
| | 5 | CABAC | PSNR gain | 0.101 | 0.011 | 0.009 | 0.233 | 0.100 | 0.150 | -0.183 |
| | | | Bitrate diff | 1.89% | 0.21% | 0.14% | 4.37% | 2.04% | 2.93% | -4.70% |
| T+MVP | 1 | UVLC | PSNR gain | 0.020 | -0.006 | 0.010 | 0.001 | 0.004 | 0.001 | 0.004 |
| | | | Bitrate diff | 0.37% | -0.13% | 0.18% | 0.03% | 0.09% | 0.02% | 0.11% |
| | 5 | UVLC | PSNR gain | 0.063 | -0.009 | 0.025 | 0.016 | 0.033 | 0.015 | -0.028 |
| | | | Bitrate diff | 1.14% | -0.18% | 0.43% | 0.30% | 0.70% | 0.31% | -0.70% |
| T+MVP | 1 | CABAC | PSNR gain | 0.011 | -0.004 | 0.006 | 0.003 | -0.001 | 0.002 | 0.006 |
| | | | Bitrate diff | 0.20% | -0.08% | 0.09% | 0.06% | -0.01% | 0.05% | 0.16% |
| | 5 | CABAC | PSNR gain | 0.025 | -0.015 | 0.018 | 0.014 | 0.023 | 0.016 | -0.024 |
| | | | Bitrate diff | 0.47% | -0.27% | 0.31% | 0.27% | 0.48% | 0.34% | -0.62% |
| T+MVP RDO | 1 | UVLC | PSNR gain | 0.069 | 0.439 | 0.106 | 0.370 | 0.144 | 0.629 | 0.226 |
| | | | Bitrate diff | 1.26% | 8.27% | 1.87% | 6.81% | 2.96% | 12.15% | 5.48% |
| | 5 | UVLC | PSNR gain | 0.111 | 0.406 | 0.119 | 0.393 | 0.163 | 0.676 | 0.196 |
| | | | Bitrate diff | 2.00% | 7.53% | 2.07% | 7.29% | 3.33% | 12.19% | 4.66% |
| T+MVP RDO | 1 | CABAC | PSNR gain | 0.040 | 0.390 | 0.107 | 0.288 | 0.113 | 0.529 | 0.196 |
| | | | Bitrate diff | 0.73% | 7.26% | 1.80% | 5.36% | 2.29% | 10.32% | 4.79% |
| | 5 | CABAC | PSNR gain | 0.056 | 0.375 | 0.120 | 0.304 | 0.127 | 0.550 | 0.159 |
| | | | Bitrate diff | 1.05% | 6.91% | 1.97% | 5.64% | 2.59% | 10.40% | 3.82% |
| Draft | 5 | UVLC | PSNR gain | -0.012 | -0.047 | -0.018 | -0.003 | 0.000 | -0.080 | -0.120 |
| | | | Bitrate diff | -0.22% | -0.90% | -0.32% | 0.07% | 0.00% | -1.72% | -3.03% |
| | 5 | CABAC | PSNR gain | -0.003 | -0.042 | -0.016 | 0.000 | 0.004 | -0.067 | -0.112 |
| | | | Bitrate diff | -0.05% | -0.78% | -0.26% | -0.01% | 0.08% | -1.43% | -2.85% |

Fig. 21

Comparison of encoding performance for different values of $\lambda$.

| *A* | $QP_B$ | Sequence | Foreman | Container | News | Paris | Silence | Mobile | Tempete |
|---|---|---|---|---|---|---|---|---|---|
| *500* | $QP_P$ | PSNR | 0.128 | -0.015 | 0.084 | 0.117 | 0.039 | 0.280 | 0.156 |
| | | Bitrate | 3.43% | -0.33% | 2.01% | 2.85% | 1.06% | 6.35% | 3.89% |
| | $QP_P+1$ | PSNR | 0.102 | -0.111 | 0.057 | 0.048 | 0.005 | 0.133 | 0.094 |
| | | Bitrate | 2.58% | -2.78% | 1.39% | 1.19% | 0.16% | 3.04% | 2.35% |
| *700* | $QP_P$ | PSNR | 0.070 | 0.034 | 0.061 | 0.079 | 0.009 | 0.176 | 0.086 |
| | | Bitrate | 1.87% | 0.79% | 1.43% | 1.97% | 0.19% | 4.08% | 2.19% |
| | $QP_P+1$ | PSNR | 0.060 | -0.012 | 0.043 | 0.046 | 0.002 | 0.090 | 0.057 |
| | | Bitrate | 1.60% | -0.35% | 0.97% | 1.16% | 0.03% | 2.19% | 1.52% |

*Fig. 22*

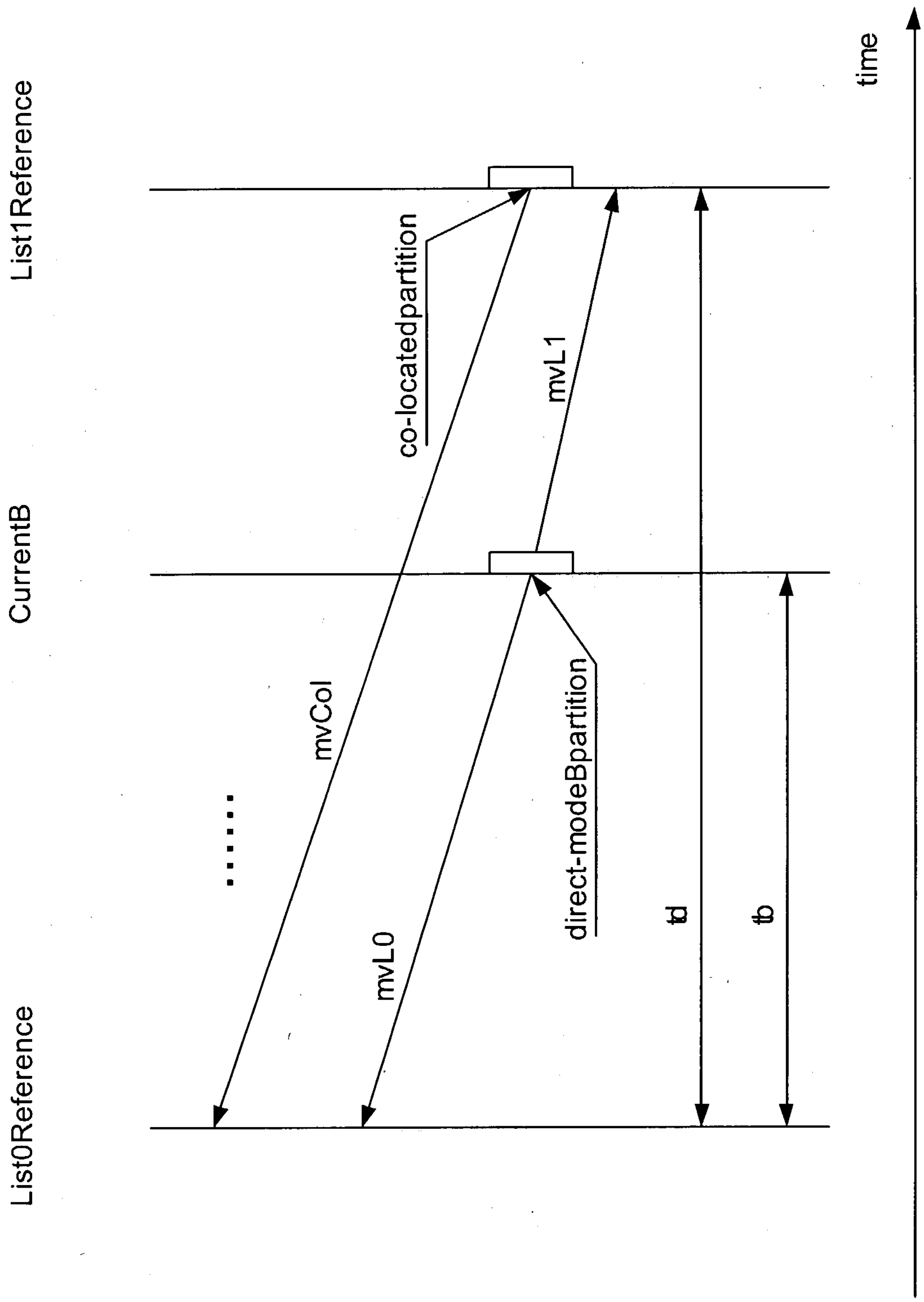

List1Reference
CurrentB
List0Reference
co-locatedpartition
mvL1
mvCol
mvL0
direct-modeBpartition
td
tb
time

Fig. 23